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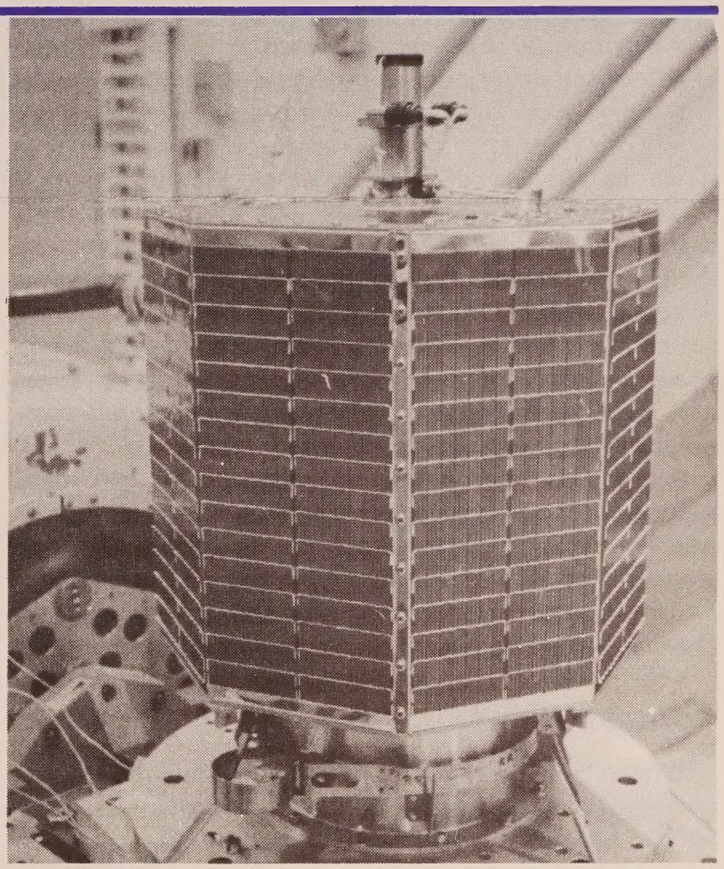
AMSAT SATELLITE REPORT

World Watches as Hobbled Bird Lingers

A worldwide family of Amateur Satellite users watched anxiously over the past days as AMSAT engineers, controllers and managers tried to piece together a picture of AMSAT-OSCAR 7 while the old bird lay perilously close to the end of its productive life. Serious problems began to show up June 11 and 12 when the satellite was not fully responding to commands. By late on June 12 it was evident that the problem was serious and the AO-7 Ground Command Team notified AMSAT management that the bird was apparently in serious trouble. By press time (late June 15) a number of important observations and analyses had been made. And AO-7 had, to a user community hungry for any favorable sign, given a few tantalizing hints of life. This Special Edition of *ASR* will present the story of the crisis in AO-7's recent history from a number of perspectives. We'll look at some of the major accomplishments in AO-7's long life, examine some hypotheses on its present malady and sample reaction to the grave condition of our friend AMSAT-OSCAR 7.



Engineers Evaluate Symptoms

AMSAT engineering staff were analysing the dirth of data that existed in hopes of obtaining some clues to the nature of the malfunction that has caused a spacecraft emergency to be declared. AMSAT-OSCAR 7 began showing signs of malfunction beginning with approximately orbit 30060 on 11 June and with increasing severity and frequency of occurrence thereafter until by 30072 on 12 June, it was apparent to quite a number of observers that something was seriously amiss. The last confirmed QSO took place on orbit 30075 with VK3ACR participating.

From about that time onward, the transponders and beacons on AO-7 exhibited a worrisome silence and numerous stations were placed on full alert to watch all frequencies on every possible orbit. This stratagem paid off early Sunday when WD4FAB reported hearing weak but detectable transponder hash (but not transponder throughput) on 145.9 MHz. W6ELT heard the same on a later orbit. Finally on 30104 W6CG heard several stations who were putting test signals through the B transponder, if only very weakly.

Based on these observations, a slim glimmer of hope can be proffered, that the present conditions are reversible, AMSAT Officials confirmed Monday, 15 June 81. While at first it was feared that the malfunction had been catastrophic and total with no symptoms at all to diagnose, now there are a few pieces of the puzzle to assemble, said these officials. Jan King, W3GEY, AMSAT Vice President for Engineering, stated that he felt a 5 or 10 degree Celsius thermal shock caused by the sudden exposure to deep shadow might have been enough to cause a failure in one of the weakened, aged, NiCad batteries. Such a failure mechanism might come about through non-uniform heating of a cell causing, for example, the plate separators to warp and causing a short circuit. If this hypothesis is valid, the question is: "Is this a

Engineers Evaluate Symptoms *(Continued from page 1)*

reversible condition?" The answer to that one is anybody's guess. An encouraging sign is, according to K1HTV and WA2LQQ, that there seems to be a continuum of malfunction symptoms. That is, there are all degrees of failure of AO-7 which seem to vary unpredictably (for the present) with time. On one occasion the transmitter will be on (noise is heard but no throughput). On another occasion oscillations are being heard in the "usual" spots on 2 meters. On yet another occasion everything seems to be working, if weakly, except the telemetry beacons. And so forth. Does this spectrum of malfunctions correspond to a time-varying voltage? And is this voltage a function of eclipse duration? If so, then the moratorium on use combined with the reduced length of the eclipse duration should show some results in the next week or ten days. A good sign would be the more consistent occurrence of one or more of the major functions with the more the better. On the other hand, if clear improvement does not become apparent in, say 3 or 4 weeks, then we'll have to concede that the end of the line may be very near indeed. K1HTV points out that in addition to the duration of the eclipse, his telemetry record, supplied mainly by KH6OS, shows some evidence suggesting that disadvantageous sun angle may be a contributory factor in lowering overall electrical energy available.

In conclusion, what seems most obvious is that there is quite likely a strong correlation between the eclipse of AO-7 and its present maladies. Beyond that, speculation abounds and facts are few. Nevertheless, given the long history and very recent circumstance, there is at least a chance that AO-7 will be back on line soon.

June A Jinx?

While AMSAT-OSCAR 7 may indeed survive a period of deep eclipse shadow, observers with long memories for bad news recalled that it was precisely four years ago June 15 that another old friend, AO-6, expired. It was June 15, 1977 when W6CG, Bud Schultz and W6ELT, George Dillon, tried in vain to extract AO-6 from its "death spiral" during which the battery failed. On that occasion the satellite would not respond to commands with the fatal result of cataclysmic battery failure. On balance, however, no direct connection should be inferred between the date of the ultimate failure of AO-6 and the present difficulties with AO-7, AMSAT Officials emphasized. If there is some obscure, indirect connection involved having to do with the position of the orbital plane with respect to the terminator, no AMSAT Official contacted would speculate on one. For the record, however, the following dates may be of interest: AO-6; launched 15 Oct. 72; design life 1 year; failed 15 June 77 after 4½ + years of operation. AO-7 launched 15 Nov. 74; design life 3 years; now has 6½ years of operation.

Publisher's Note: This issue of *ASR* was compiled ahead of schedule in order to give you complete details concerning the status of OSCAR 7. The next regular issue of *ASR* will be dated July 13 bringing production back to the normal bi-weekly cycle.

AO-7 Operations Moratorium Asked

In an urgent bulletin to all Amateur Radio organizations involved in satellite activities, AMSAT Headquarters asked for immediate cessation of use of the AO-7 transponder should it appear on during the present spacecraft emergency. As detailed elsewhere in this *ASR* edition, AMSAT Officials have concluded, based on preliminary findings, that there is at least a reasonable possibility that the current crisis is directly related to the duration of the eclipse experienced by AO-7 on each orbit. If this is factual, then there is a further possibility that AO-7 could recover from the present uncertain prognosis. Even more optimistic is a comment bantied about that the deep discharge on the nickel-cadmium cells might help them in the long run. In other words, the optimists in AMSAT are saying that if the present crisis can be survived, a period of "June in December" youthful health might result in AO-7's behavior. While that might seem too much to hope for it is at least an interesting discussion point and does have some basis (if only a bit) in fact. The moratorium on AO-7 use is designed to afford the engineers and analysts the opportunity to test various hypotheses and to formulate a "get well" plan that will maximize survival chances. The text of the message follows:

TO: *All Radio Amateurs*
FM: *AMSAT HQ, Washington, D.C.*
SUBJ: *AO-7 Operations*
DTG: *15 June 81, 1800 hrs UTC*

As is known to you, AO-7 is presently exhibiting alarming malfunction symptoms which began on or about 12 June 81. The transponder has been inoperative except for a few short intervals and the satellite has otherwise remained mute despite repeated command attempts. While a catastrophic failure does not appear to have occurred, it is clear that the added thermal and electrical stress of the present deep shadow eclipse intervals has the potential to be the coup de gras.

Therefore, it is the concensus of the AMSAT staff that the highest probability of surviving the present crisis will result from the complete cessation of transponder use, if it becomes available, for an indeterminate period. If this regime is successful, it may lead to extension of AO-7's life for perhaps another season. All coordinators are urged to encourage abstinance on AO-7 use, and to report telemetry frames obtained to K1HTV (AMSAT HQ) on an urgent, priority basis. Further advice to follow. Please QSP widest possible.

Area Coordinator Update

AMSAT's Vice President for Operations, Rich Zwirko, K1HTV has announced the appointment of two new area coordinators. They are: John McDonald, WB4ZXS for Central Florida; Jack Somers, WA6VGS for Southern California/Los Angeles. WB4ZXS replaces W4MID who resigned recently. K1HTV expressed thanks to W4MID on behalf of AMSAT for a job well done. K1HTV accepted W4MID's resignation 12 June 81 with deepest regrets. WA6VGS assumes a new slot in L.A. mandated by the large user population. WA6VGS joins W6CG and K6PGX in serving the huge SoCal vicinity. Congratulations to John and Jack!

Spotlight on AO-7: The Record Reviewed

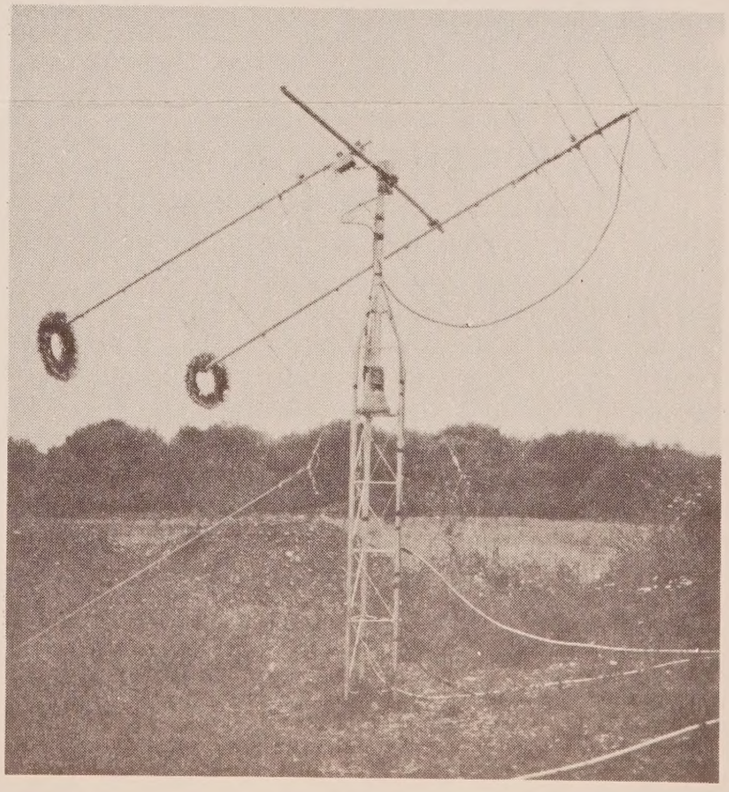
While it is certainly too early to begin writing AO-7's obituary, it might be appropriate to review the exemplary record AMSAT-OSCAR 7 has set forth. First, a few of the statistics and facts about AMSAT-OSCAR 7 to set the framework for its operational achievements.

AO-7 was launched 15 Nov. 74 at 1711 UTC from Vandenberg AFB, CA aboard a Delta launch vehicle. Its co-passengers were the NOAA-4 and ITOS-G satellites. AO-7 weighs 64 lbs (29 kg). As of 15 June, AO-7 had completed 30,120 orbits or 57,715 hours or 2405 days, or 6.6 years in orbit. Its design life was 3 years. It is even now among the longest lived of ALL spacecraft in orbit—an enviable record by anyone's standard. AO-7 is in an orbit which is very nearly circular having an ellipticity of only 0.0011158. The deviation from a perfectly circular orbit is approximately that of the equatorial bulge or oblateness of the earth caused by its spinning on axis. A recent measurement had apogee at 918 miles (1478 km) and perigee at 898 miles (1445 km). The orbit is inclined 101.4124 degrees. The Mode B transponder was built by AMSAT DL, the 435.1 MHz beacon by Canadians, the RTTY telemetry encoder by Australians, the SHF (2304 MHz) beacon and Mode A transponder by Americans. (The SHF beacon was never authorized for use by the FCC and was never turned on.) The Mode A transponder was rated at 2 watts PEP while the Mode B transponder could produce 10 watts PEP or 2.5 watts PEP (Mode C). Mode B was probably the most popular mode in all satellite history. It certainly was the most convenient downlink to listen to with its extraordinarily strong 2 meter signals audible even on a hand-held transceiver with "rubber duckie".

In the 6.6 years AO-7's been aloft, if there have been on average only 33 QSOs per orbit, then there have been more than a MILLION QSOs on AO-7. Other estimates are considerably higher. For example, it seems easy to visualize how an average of only 200 QSOs per orbit might transpire. That results in over 6,000,000 QSOs. Is that incredible? Looked at another way, it is likely that between 10,000 to 15,000 different amateurs have accessed AO-7 and actually put signals through it. Perhaps another 10,000 or so have monitored it on one occasion at least. Quite a record for a little 29 kg bird built in basements around the world!

Specific achievements on AO-7 are literally too numerous to mention. But here are a few of the prominent ones.

- A new VHF transequatorial propagation mode was discovered when YV5ZZ heard LU7DJZ's 2 meter uplink to AO-7A in November 76. The new ionospheric propagation mode was documented in *QST* for January 78 by W3XO in his column, "The World Above 50 MHz".
- In 1976 a series of experiments proved medical data (EKGs) could be sent by satellite when W6ELT sent data tapes to W3UN at the National Institute of Health station, K3YGG. The tapes had been provided by K7RGE of the University of Arizona, Tucson and were analyzed by W3QBC. Later in January 76, W2GN sent tapes from his mobile OSCAR station in Albany, New York to the Institute.
- In early February 76 began a dramatic series of demonstrations of a precedent setting nature when the first ever satellite to satellite links were accomplished by stations transmitting on the AO-7B uplink. These signals were then picked up by the then operative AO-6 Mode A receiver and transponded to 29.45 MHz. Dozens of contacts were thus made and the experiment was repeated on several occasions throughout that year when the two birds were close to each other in their respective orbits.
- APT satellite pictures were transmitted for European consumption in April/May 76 by DLØVB as part of an experiment which proved very successful.
- Many mobile tests were run using AO-7. W2GN plied his (in)famous automobile, W6OAL his aeromobile and WA4JID his marinemobile.
- QRP tests in June 76 on Mode B showed that a few milliwatts ERP were sufficient for a perceiveable downlink. Hundreds (thousands?) of QSOs transpired using 10 watts ERP or less on AO-7B.
- An STA was granted by the FCC for use of ASCII on AO-7 for the express purpose of allowing Phase III control staions to test the new PSK modulation scheme on AO-7.



When on Saturday, 13 June 81, it appeared that AO-7 was lost, this scene was photographed at WA2LQQ. Here is seen the array bowed in honor of a lost comrade much as is the tradition of a naval gunnery officer who lowers his armaments thus. Wreaths are seen adorning the "muzzle" end. If AO-7 could speak of its own accord, it might say (perhaps in RTTY with marks, spaces and twains): "Reports of my demise are somewhat premature."

•President of the United States Gerald Ford spoke through AO-7 during the dedication of the Air and Space Museum in Washington, D.C.
•AO-7 was used on both arctic and antarctic expeditions. To the north, AO-7 was used by the Arctic Geographic Cruise. (WA6PSR) On the southern extreme, ZS1FE heard his own AO-7 return dozens of times but could not QSO due to his remote QTH.
•Emergency Locator Transmitter (ELT) tests which had begun on AO-6 were continued on AO-7 with positive results.
•HA5WH demonstrated the feasibility of direct satellite to home FM boradcast in 1975.
•Voice bulletins to AMSAT members and to the general radio amateur population were accomplished by: (among a very large team) K2BZT, W1NU, W3BWU, K1HTV, W2GN, W4MOP, W6CG, W6ELT, W4BE, and with WA4JID doing his special hurricane-watch transmissions on AO-7.
•Educational uses of AO-7 in the grammar schools, high schools and at college level were evident. W2GN led the way with WØCY.
•Special events stations colored AO-7's proud history with an especially brilliant hue. From Space-Com to the Boy Scouts International Hamboree, AO-7 did the job well.
•Codestore messages carried everything from holiday greetings in several languages to 200th birthday greetings to the USA in 1976. Congratulations to UK's Queen Elizabeth were also in codestore.

Yes, AMSAT-OSCAR 7 has been a wonderful friend these years and we will, if absolutely required of us, part company with him. Yet we can't help wish that he would just stick around a bit longer so that we could have just one or two more FB QSOs on Mode B. Maybe. Time will tell the tale. We should know within a week or two whether this is goodbye to seven or if we will have a respite. In either case, we are grateful for the delight and sense of accomplishment we've all had. Hooray for OSCAR 7!!!—*K1HTV, WA2LQQ*

15 June Worst Day For AO-7?

An illuminating analysis by KA9Q, Phil Karn, has revealed that the time of deepest shadow for AO-7 occurred on 15 June when the time interval was the longest. Phil's model resides in a powerful computer at the Bell Labs facility near Chicago. The model had predicted that the eclipse season for AO-7 would commence on or about 1 June (see *ASR* #8, page 1). An excellent article which today takes on special relevancy appears in *ORBIT* #6 for March/April 81, page 21: AMSAT-OSCAR 7 Between Sunlight and Shadow by DL3ZK, Juergen Raddatz.

KA9Q's computer analysis also reveals reason to hope that the worst may have past. The data shows the onset of the eclipse season at 1 June and the end at 4 or 5 July with the maximum duration eclipse occurring on 15 June. AO-7's orbit is at present at a position to cause the satellite to fall into shadow once each orbit when the bird is near the South pole. Phil's model is a simple one and thus does not account for various optical effects encountered in the real world such as forward scattering of light, refraction by the atmosphere, etc. In effect, the model treats the earth as if it had no atmosphere and as if light were particulate (photon model). Thus, the earth in this model provides a clean "knife edge" and perfectly black shadows with no twilight zone. While this model is acknowledged to be deficient in these areas, it nevertheless provides valuable insight to the trends and relative insolation. Based on his model, Phil says the maximum eclipse interval duration is 7.5 to 8 minutes on 15 June and falls off to zero from this center point to 1 June and 5 July reasonably symmetrically. For example, on 4 June and 1 July the duration is predicted to be 5 minutes.

A longer view to trends was revealed by K1HTV and W3IWI who observed that the late spring season each year has seen AO-7 in deeper shadow (also interpreted as LONGER eclipse duration). Last year, this period was marked by failure of the telemetry beacon probably associated with falling power availability. AO-7 has been a wounded bird since a devastating battery failure in 1978 very nearly cost the entire mission. It is extremely fortunate that the cell that failed in 78 failed in the "open" mode, thus acting as a resistor in series with the remaining cells, rather than doing the typical NiCad failure routine of simply shorting out and drowning the entire supply. In effect, then, we have been getting gratis time for the last three years.

The present anomalies may indicate a change in the condition of that failed cell or it may indicate changes in other cells. K1HTV says that the telemetry he's been receiving shows a long term trend of rising voltage on the remaining cells. This is assumed to be a favorable omen perhaps indicating some healing going on in the cells. How the present difficulties will affect that trend is not at all clear at this time, said K1HTV. Words heard around AMSAT expressed hope that, if the present crisis were directly related to the duration of the eclipse interval, that upon emergence from this period in about 10 days, the satellite will be found to have suffered minimal permanent damage. Is it too much to hope that these conditions be reversible? We'll have to wait and see.

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